

Appendix B

ASTM Q-Curve Procedures

ASTM Q-Curve Algorithm

The following text, figures and related procedure was taken directly from the ASTM standard for the rating of roadway pavements.

9. Calculation of PCI for Asphalt Concrete (AC) Pavement

9.1 Add up the total quantity of each distress type at each severity level, and record them in the "Total Severities" section. For example, Figure 4 shows five entries for the Distress Type 1, Alligator Cracking": 5L, 4L, 4L, 8H, and 6H. The distress at each severity level is summed and entered in the "Total Severity" section as 13 ft² (1.2 m²) of low severity and 14 ft² (1.3 m²) of medium severity. The units for the quantities may be either in square feet (square meters), linear feet (meters), or number of occurrences, depending on the distress type.

9.2 Divide the total quantity of each distress type at each severity level from 9.1 by the total area of the sample unit and multiply by 100 to obtain the percent density of each distress type and severity.

9.3 Determine the deduct value (DV) for each distress type and severity level combination from the distress deduct value curves in Appendix A.

9.4 Determine the maximum corrected deduct value (CDV). The procedure for determining maximum CDV from individual DVs is identical for both AC and PCC pavement types.

9.5 The following procedure must be used to determine the maximum CDV.

9.5.1 If none or only one individual deduct value is greater than two, the total value is used in place of the maximum CDV in determining the PCI; otherwise, maximum CDV must be determined using the procedure described in 9.5.2-9.5.5.

9.5.2 List the individual deduct values in descending order. For example, in Figure 6 this will be 25.1, 23.4, 17.9, 11.2, 7.9, 7.5, 6.9, and 5.3.

9.5.3 Determine the allowable number of deducts, m, from Figure 5, or using the following formula (see Eq 4):

$$m = I + (9/98)(100 - HDV) \leq 10 \quad (4)$$

where:

m = allowable number of deducts including fractions (must be less than or equal to ten), and
HDV = highest individual deduct value.
(For the example in Figure 4, $m = I + (9/98)(100 - 25.1) = 7.9$).

9.5.4 The number of individual deduct values is reduced to the m largest deduct values, including the fractional part. For the example in Figure 6, the values are 25.1, 23.4, 17.9, 11.2, 7.9, 7.5, 6.9, and 4.8 (the 4.8 is obtained by multiplying 5.3 by $(7.9 - 7 = 0.9)$). If less than III deduct values are available, all of the deduct values are used.

9.5.5 Determine maximum CDV iteratively, as shown in Figure 6.

9.5.5.1 Determine total deduct value by summing individual deduct values. The total deduct value is obtained by adding the individual deduct values in 9.5.4, that is, 104.7.

9.5.5.2 Determine q as the number of deducts with a value greater than 2.0. For example, in Figure 6, $q=8$.

9.5.5.3 Determine the CDV from total deduct value and q by looking up the appropriate correction curve for AC pavements in Appendix A.

9.5.5.4 Reduce the smallest individual deduct value greater than 2.0 to 2.0 and repeat 9.5.5.1-9.5.5.3 until $q=1$.

9.5.5.5 Maximum CDV is the largest of the CDVs.

9.6 Calculate PCI by subtracting the maximum CDV from 100: $PCI = 100 - \text{max CDV}$.

9.7 Figure 6 shows a summary of PCI calculation for the example AC pavement data in Figure 4. A blank PCI calculation form is included in Figure 2.

10. Calculation of PCI for Portland Cement Concrete (PCC) Pavement

10.1 For each unique combination of distress type and severity level. Add up the total number of slabs in which they occur. For the example, in Figure 7, there are two slabs containing low-severity corner break (Distress 22L).

10.2 Divide the number of slabs from 10.1 by the total number of slabs in the sample unit and multiply by 100 to obtain the percent density of each distress type and severity combination.

10.3 Determine the deduct values for each distress type severity level combination using the corresponding deduct curve in Appendix A.

10.4 Determine PCI by following the procedures in 9.5 and 9.6, using the correction curve for PCC pavements (see Appendix A) in place of the correction curve for AC pavements.

10.5 Figure 7 shows a summary of PCI calculation for the example PCC pavement distress data in Figure 8.

11. Determination of Section PCI

11.1 If all surveyed sample units are selected randomly or if every sample unit is surveyed then the PCI of the section is the average of the PCIs of the sample units. If additional sample units, as defined in 2.1.1, are surveyed then a weighted average is used as follows:

$$PCI_s = (N - A)(PCI_R)/N + A(PCI_A)/N \quad (5)$$

Where:

PCI_s = weighted PC' of the section,
 N = total number of sample units in the section,
 A = number of additional sample units,
 PCI_R = mean PCI of randomly selected sample units, and
 PCI_A = mean PC' of additional selected sample units.

11.2 Determine the overall condition rating of the section by using the section PCI and the condition rating scale in Figure 10.

ASPHALT SURFACED ROADS AND PARKING LOTS CONDITION SURVEY DATA SHEET FOR SAMPLE UNIT										SKETCH:		
BRANCH <u>SPRINGFIELD</u> SECTION <u>001</u> SAMPLE UNIT <u>1</u> SURVEYED BY <u>KAK</u> DATE <u>10 JUL 93</u> SAMPLE AREA <u>2500 sq ft</u>												
1. Alligator Cracking		6. Depression		11. Patching & Util Cut Patching		16. Shoving						
2. Bleeding		7. Edge Cracking		12. Polished Aggregate		17. Slippage Cracking						
3. Block Cracking		8. Jt. Reflection Cracking		13. Potholes		18. Swell						
4. Bumps and Sags		9. Lane/Shoulder Drop Off		14. Railroad Crossing		19. Weathering/Raveling						
5. Corrugation		10. Long & Trans Cracking		15. Rutting								

DISTRESS SEVERITY	QUANTITY								TOTAL	DENSITY %	DEDUCT VALUE
1 L	1 x 5	1 x 4	1 x 4						13	0.52	7.9
1 H	1 x 8	1 x 6							14	0.56	23.4
7 L	32	15	18	24	41				130	5.20	7.5
8 H	20	15	35	27	23	10	13		143	5.72	25.1
11 H	3 x 4	2 x 5							22	0.88	17.9
13 L	1								1	0.04	11.2
15 L	4	9	8						21	0.84	6.9
19 L	250								250	10.0	5.3

FIG. 4 Example of a Flexible Pavement Condition Survey Data Sheet

Adjustment of Number of Deduct values

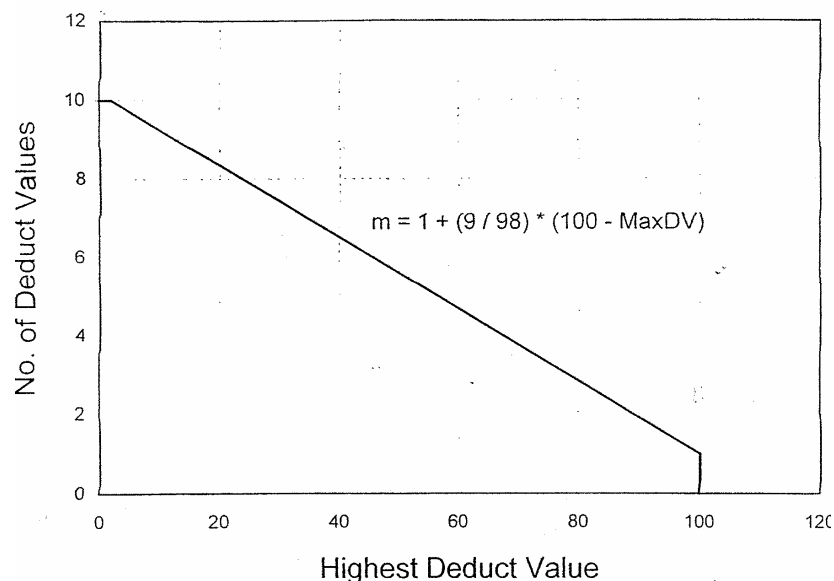


FIG. 5 Adjustment of Number of Deduct Values

$$m = 1 + (9/98)(100 - 25.1) = 7.9 < 8$$

Use highest 7 deducts and 0.9 of eighth deduct.

$$0.9 \times 5.3 = 4.8$$

#	Deduct Values										Total	q	CDV
1	25.1	23.4	17.9	11.2	7.9	7.5	6.9	4.8			104.7	8	51.0
2	25.1	23.4	17.9	11.2	7.9	7.5	6.9	2			101.9	7	50.0
3	25.1	23.4	17.9	11.2	7.9	7.5	2	2			96.0	6	46.0
4	25.1	23.4	17.9	11.2	7.9	2	2	2			90.5	5	47.0
5	25.1	23.4	17.9	11.2	2	2	2	2			84.6	4	48.0
6	25.1	23.4	17.9	2	2	2	2	2			75.4	3	48.0
7	25.1	23.4	2	2	2	2	2	2			59.5	2	44.0
8	25.1	2	2	2	2	2	2	2			38.1	1	38.0
9													
10													

$$\text{Max CDV} = \underline{51}$$

$$\text{PCI} = 100 - \text{Max CDV} = \underline{49}$$

$$\text{Rating} = \underline{\text{FAIR}}$$

FIG. 6 Calculation of Corrected PCI Value—Flexible Pavement

Type #'s should be corrected - see Fig 3

BRANCH SECOND SECTION 001 SAMPLE UNIT 1
SURVEYED BY KTJ DATE 10 Jul 93 SAMPLE AREA 20 slabs

SKETCH: 20' x 15' ea

- | | | | | |
|---|------------|------------|---|----|
| | | | | 10 |
| | 23M | | | 9 |
| | 30L
38L | 30L
38L | | 8 |
| | 22L | 22M
38L | | 7 |
| | 22L | 22L | | 6 |
| | 38L | | | 5 |
| | 34M | | | 4 |
| | | 34M | | 3 |
| | 30L | | | 2 |
| | 23M | 30L | | 1 |
| | 38L
39H | 23M
38L | | |
| 1 | 2 | 3 | 4 | |

[illegible]

FIG 8

#	Deduct Values										Total	q	CDV
1	30.5	25.1	12.6	9.0	8.0	7.7	5.8	1.76			100.5	7	50.0
2	30.5	25.1	12.6	9.0	8.0	7.7	2	1.76			96.7	6	49.5
3	30.5	25.1	12.6	9.0	8.0	2	2	1.76			91.0	5	51.0
4	30.5	25.1	12.6	9.0	2	2	2	1.76			85.0	4	49.0
5	30.5	25.1	12.6	2	2	2	2	1.76			78.0	3	50.0
6	30.5	25.1	2	2	2	2	2	1.76			67.4	2	50.0
7	30.5	2	2	2	2	2	2	1.76			44.3	1	44.3
8													
9													
10													

$$m = 1 + 9/98 (100 - DV_{max}) = 7.38 < 8$$

$$2 \quad 4.4 \times 0.4 = 1.76$$

$$\text{Max CDV} = \underline{51}$$

$$\text{PCI} = 100 - \text{Max CDV} = \underline{49}$$

$$\text{RATING} = \underline{\text{FAIR}}$$

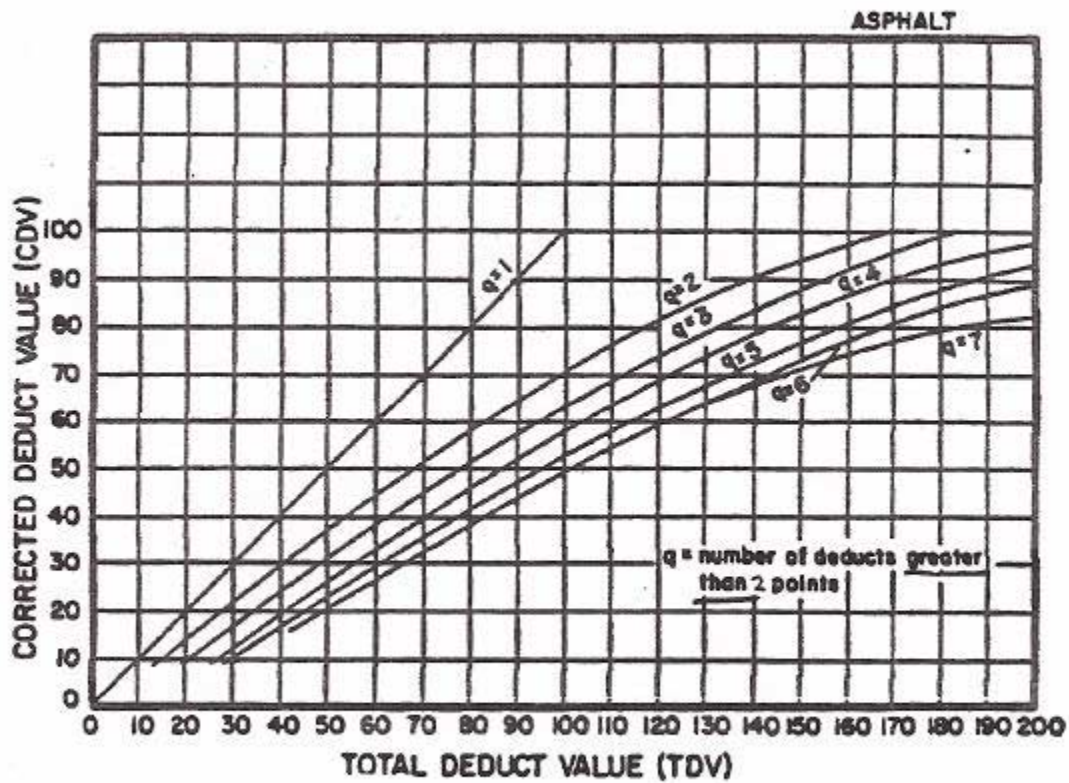


Figure B20. Corrected deduct value curves for asphalt-surfaced pavements.

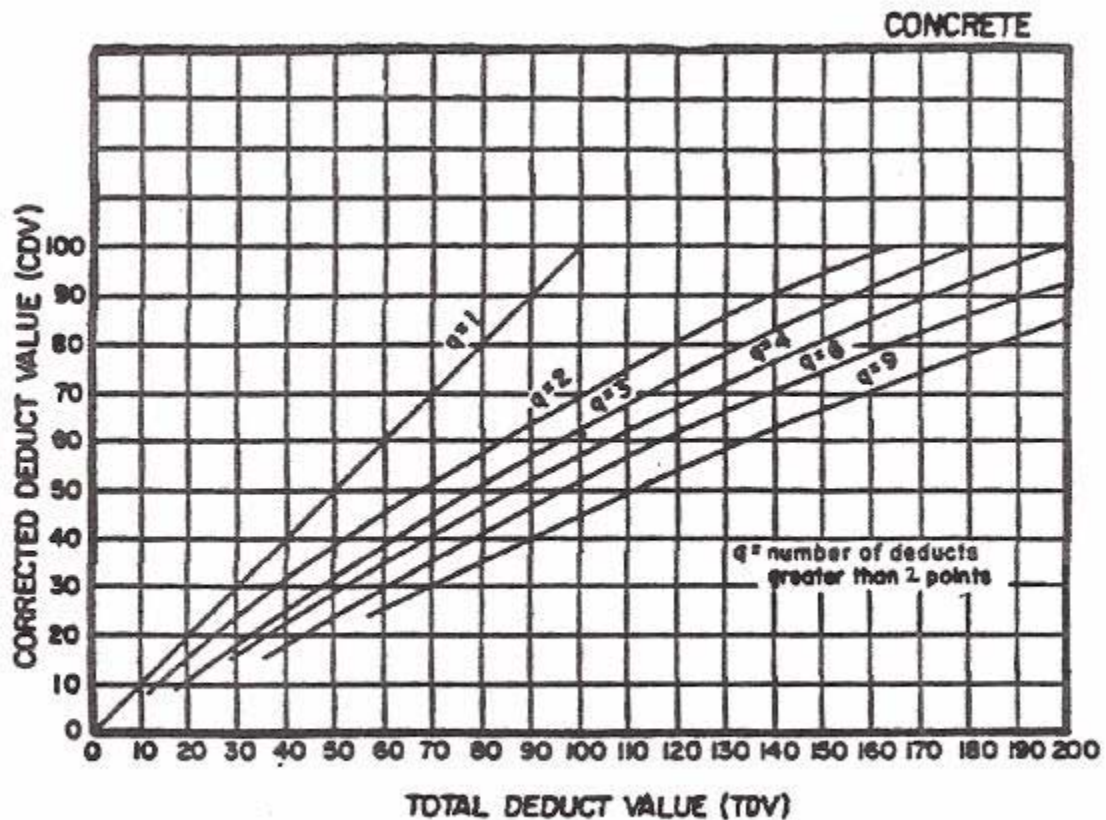


Figure Corrected deduct values for jointed concrete pavement.

Appendix C

Example Index Computation

Appendix D

Index Comparisons

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Comparison of PSC, PCR_{1,2&3}, and WSEXT/CSI Rating Methods

The following tables are provided to help the user see some of the differences between the PSC, PCR₁, PCR₃ and the WSEXT Combined Structural Index (CSI) values computed using the PAVER/ASTM deduct curves. These data were extracted from the WSDOT publication WR-RD 274.1 (September 1993) and these values represent the deduct values assigned to each distress severity and extent combination as measured and assigned based on the field data collection operations. These numbers are subtracted from 100 to compute the score. The PCR₃ was added to the original data provided by the above reference.

Figure D - Alligator Cracking Deduct Values

Extent %WP	Low Severity				Medium Severity				High Severity			
	PSC	PCR ₁	CSI	PCR ₃	PSC	PCR ₁	CSI	PCR ₃	PSC	PCR ₁	CSI	PCR ₃
1	6	20	6	7	10	35	15	14	16	50	22	21
12.5	31	20	27	38	45	35	41	52	56	50	56	68
37	65	25	40	54	84	40	54	68	96	55	70	83
62	92	45	46	54	100	45	62	68	100	60	76	83
75	100	50	49	54	100	50	64	68	100	65	79	83

Figure D2 - Patching Deduct Values

Extent %WP	Low Severity				Medium Severity				High Severity			
	PSC	PCR ₁	CSI	PCR ₃	PSC	PCR ₁	CSI	PCR ₃	PSC	PCR ₁	CSI	PCR ₃
1	5	20	2	0	9	25	10	5	14	30	19	12
5	14	20	10	21	23	25	22	38	31	30	37	62
25	41	25	25	33	57	30	45	58	68	35	72	80

Figure D3 - Transverse Cracking Deduct Values

Extent %WP	Low Severity				Medium Severity				High Severity			
	PSC	PCR ₁	CSI	PCR ₃	PSC	PCR ₁	CSI	PCR ₃	PSC	PCR ₁	CSI	PCR ₃
1	5	5	2	0	9	10	9	0	14	15	18	0
5	15	10	11	4	21	10	20	10	32	20	44	20
10	23	15	17	9	23	15	22	17	23	15	17	36

Figure D4 - Longitudinal Cracking Deduct Values

Extent %WP	Low Severity				Medium Severity				High Severity			
	PSC	PCR ₁	CSI	PCR ₃	PSC	PCR ₁	CSI	PCR ₃	PSC	PCR ₁	CSI	PCR ₃
1	1	5	0	0	3	15	0	0	5	30	4	11
100	27	15	15	n/a	40	30	28	n/a	50	45	56	n/a
200	43	30	22	n/a	59	45	38	n/a	71	60	76	n/a

Note: The PCR₃ index was added to the data in the original WSDOT report, which is provided in these tables

PSC = the index computed from the WSDOT equations

PCR₁ = Original WSDOT windshield discrete matrix method

CSI/PCI = WSEXT/PAVER/ASTM method

PCR₃ = Streetwise method

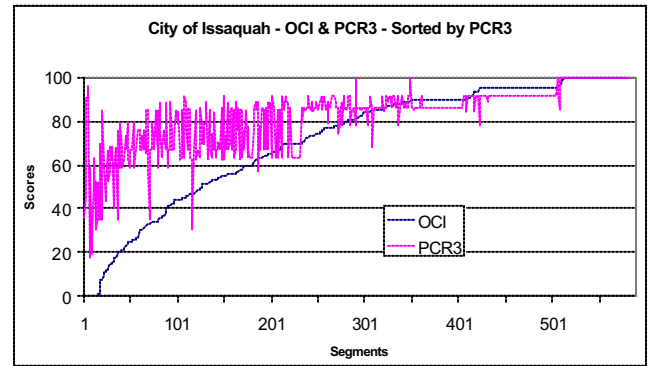
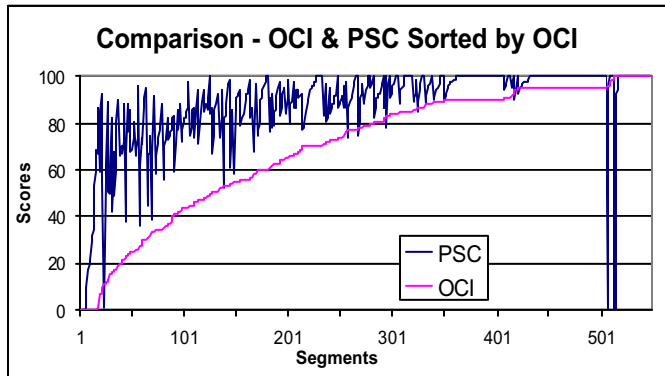


Figure D5 Comparison plot of OCI and PSC sorted by OCI

Figure D6 Comparison plot of OCI and PCR3 sorted by OCI – The above title is wrong.

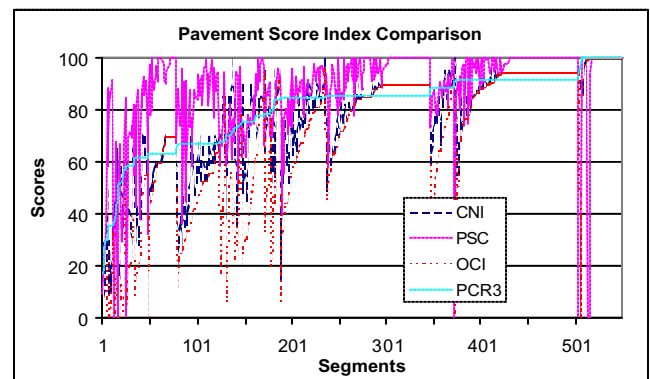
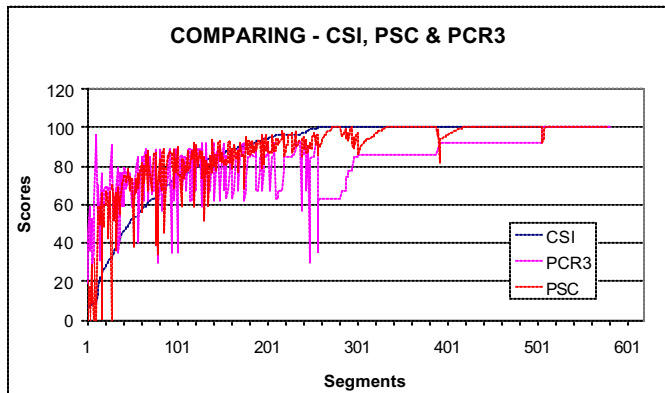


Figure D7 Comparison plot of CSI, PSC and PCR₃ sorted by CSI

Figure D8 Comparison of CSI, PSC, OCI & PCR3 sorted by PCR3 – (the CNI above should be CSI)

Figure D9 System wide index score averages

CLASS	OCI	CNI	CSI	PCR3	PSC
1	47	73	65	80	62
2	53	75	72	80	70
3	63	76	80	80	79
4	73	86	83	88	82
ALL	67	82	80	85	78

Figure D10 System wide index score averages normalized by the OCI

CLASS	OCI	CNI	CSI	PCR3	PSC
1	1	1.6	1.4	1.7	1.3
2	1	1.4	1.4	1.5	1.3
3	1	1.2	1.3	1.3	1.3
4	1	1.2	1.1	1.2	1.1
ALL	1	1.2	1.2	1.3	1.2

Figure D11 Comparison based on 10-year network analysis for a total annual budget of \$650,000

Index Used	Score Change		10 Year Deferred	Annual Added Cost
OCI	+6	68-74	\$5,879,000	-
PCR3	-10	71-64	\$7,368,000	\$148,900
PSC	-10	67-64	\$9,086,000	\$320,700
CSI	-9	66-65	\$9,108,000	\$322,900

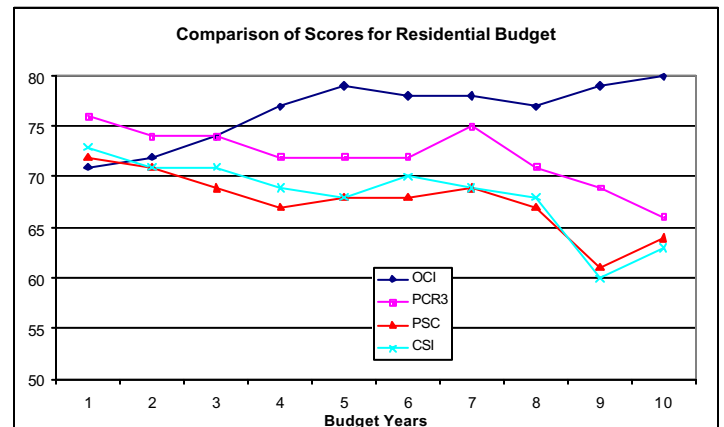
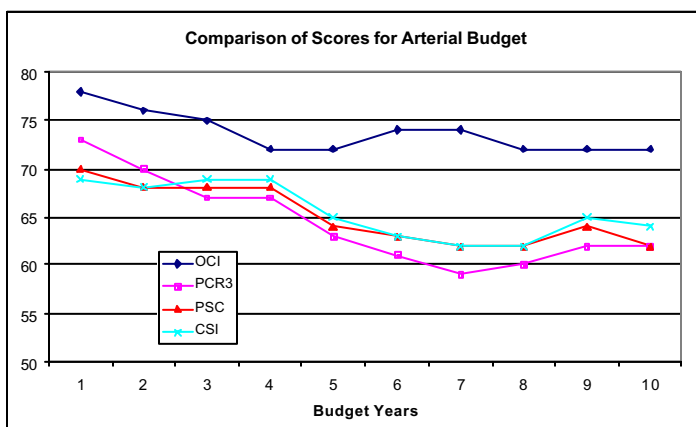
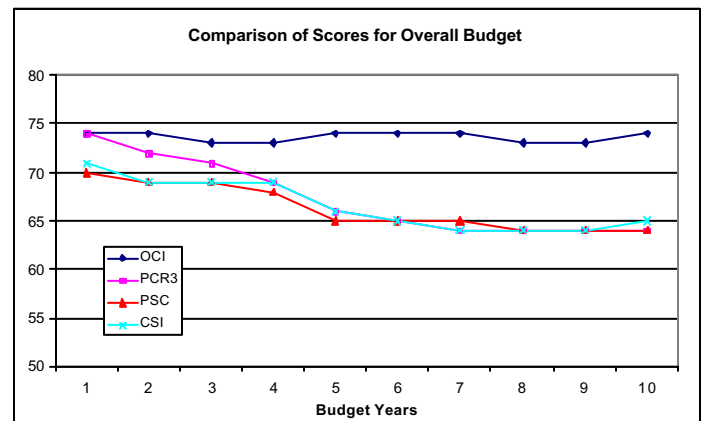
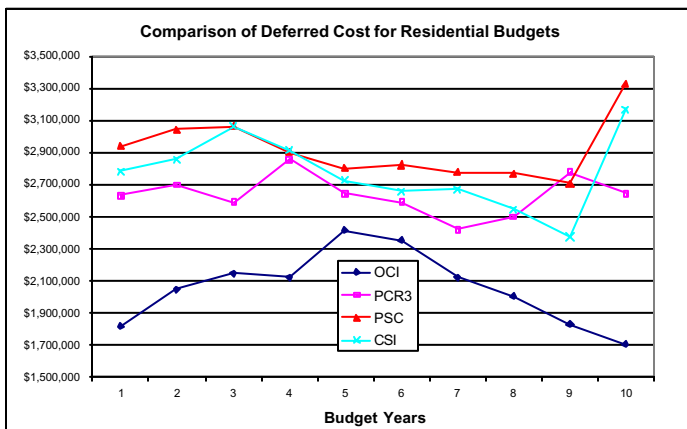
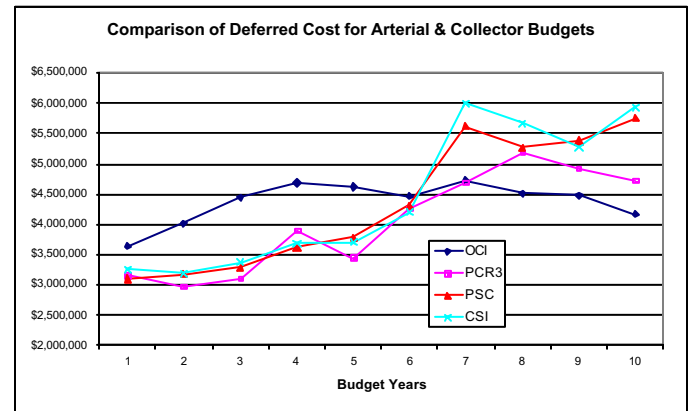
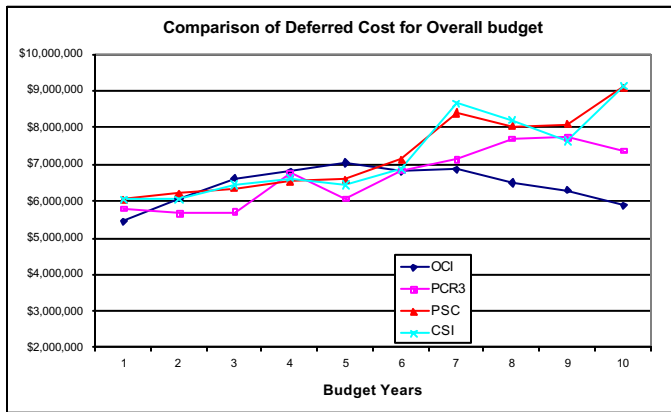


Figure D12 Comparison of each index using PMS Network Analysis

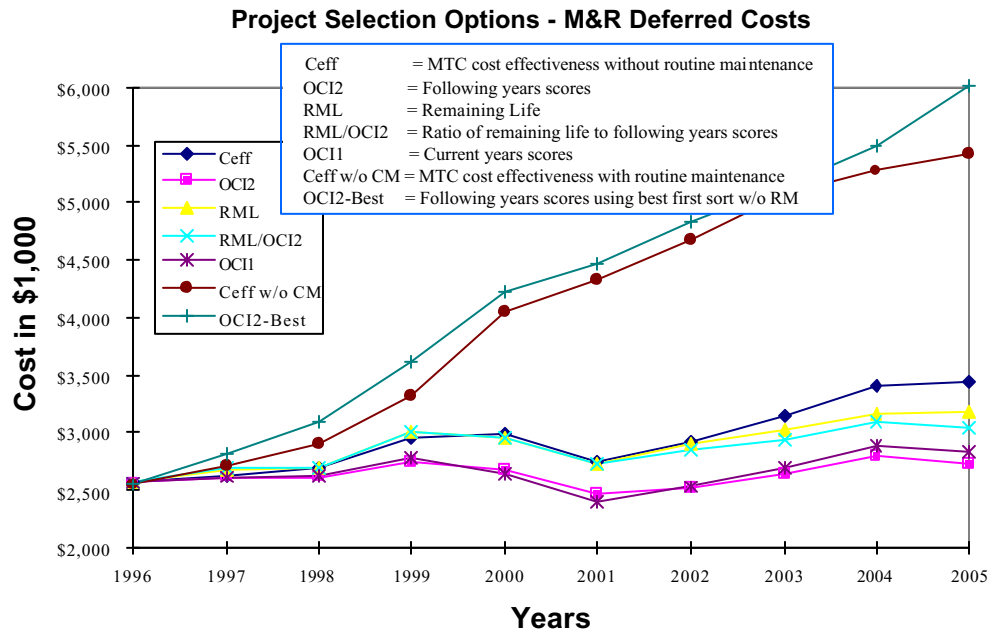


Figure D13 Deferred cost or back log for different index & sorting options – from Redmond, 1993

Evaluation of the Use of these Indices

The data used here is from the City of Issaquah, which has 49 centerline miles of streets and a population of 10,130 and a total annual MR&R budget of \$650,000.

There are two methods of evaluating the use of the different pavement distress indices, which will be presented here. The first is a simple heuristic discussion based on the above figures and the second will be based on performing a detailed optimized 10 year budget analysis using each of these indices separately, with an evaluation of the relative deferred costs (back log) produced by each and the system wide average scores. Any differences in the network analysis runs are caused by the MR&R repair lists developed by each separate index. Sense the primary objective associated with the use of any given index in PMS is to provide the data required to manage your roadway network; this is obviously the best approach to evaluating the value or performance of each of these indexes. The indices included here are the PCR_3 , PSC, CSI and the OCI. Future work will include the PCR_1 and PCR_2 . However, a comparison with these rating methods requires separate ratings of the same streets, over the same time period, using both walking and driving procedures or the simulation of the discrete data from the continuous data.

Default/Family curves were developed from each of these indices excepted for the CNI. All of these performed as expected. However, because of the higher score ranges associated with the PSC and PCR_3 , the default curves developed from these indices had higher expected lives than for the OCI/WSEXT method

The first method of evaluating these five indices is to discuss figures 5 through 8 above based solely on heuristic arguments. This approach has been taken over a more sophisticated statistical analysis for two reasons, first it is intuitive and easy to understand and second there was no simple statistical correlation found between the OCI index and the PCR_3 , PSC or the CSI. In fact even the correlation between the

PCR3, PSC and the CSI was relatively low or non-existent. This lack of correlation is obvious from the plots given above. However, in Figure 8 it appears that there is some kind of intermittent correlation between the PCR3 and the other indices. This is most likely due to the discrete nature of selecting a secondary distress type when computing this index. Further analysis of this phenomenon is beyond the heuristic nature and objective of this analysis.

To begin with, it is intuitively obvious that if a given distress or condition resulting from a given distress is not included in the development of a given index (in the data collection phase and/or index computation) it is impossible to expect your PMS related operations to reflect this condition, whether you are doing a simple prioritization (sort) based on this index or a detail network analysis. For example, see the relative index values for the OCI, PSC & PCR3 in Figure 14 below and the random scatter of the indices, which are not being sorted on, in Figures 5 through 8.

This same argument can be extended to one of the limitations in the PCR3 method, in that if a given distress condition may or may not be included in the final score value, based on the fact that any one of four given distresses may be predominate at a given time, makes it impossible to reliably make decisions based on any distress condition other than possibly fatigue cracking. Even this is suspect in that it may or may not be influenced by the same second distress for any given distress evaluation. If you look at this index in the above plots you will see that it tends to have a more stare step type appearance then the others. This is do to the rather discreet type process of selecting a single second distress type based on the predominate secondary distress. This is typical of this type of procedure in any data collection operation. This is further exemplified in Figure 8, which appears to shows intermittent correlation over the data set.

Figure 7 shows a similar trend for the CSI, PSC and PCR3. This shows that the PCR3 is more heavily influenced by fatigue cracking (structural distress) and exhibits characteristics closer to the structural indices, the PSC and CSI than to the overall combined index, the OCI/PAVER. This is further exemplified in Figures 5 & 6 where both the structural indices exhibit higher score values over the full data set (all segments) then that of the OCI.

A careful look at the index values presented in the small portion of the database shown in Figure 14 shows the extreme variation in these numbers for each individual index and between segments. There is no way that these different indexes can provide comparable repair lists or network analysis results.

Figures 9 & 10 shows the variation in the average system wide index scores for each of the indices discussed here. First, this Figure makes it clear that all indexes discussed here are 20 to 30% greater than the OCI index. This is caused by the fact that fewer distresses are included in the calculation of these indices and that the methods used to compute these scores produce these relative numbers. The relative average score values between these indices could obviously be adjusted to better compare with each other by modifying the parameters associated with each. These numbers are based on 509 rated segments and were computed from the same data set simultaneously.

Evaluation of Each Index Using Network Analysis

In addition to the above discussion, the general independent random characteristics of the PSC, PCR3 & CSI when compared to the OCI and when compared to each other, implies that any project selection process based on any one of these indices would be independent of the others. Therefore, to evaluate the value (or characteristics) of each of these independent indices, a detailed network analysis was performed using each and the results are summarized in Figure 11 and Figure 12. To allow for a reasonable comparison, the index scores for the CSI, PSC & PCR3 were scaled to give similar average system wide

score values to that of the OCI. The numbers in Figure 11 were used to perform the following evaluation and the plots in Figure 12.

As was shown in the CenterLine PMS Technical manual, (Figure 13) any variation in the index used to optimize the network can affect the results substantially. Figure 11 and Figure 12 are based on a ten-year analysis, using the same budget levels. These budget levels were established by developing an optimal solution using the OCI index. Thus all other runs are being compared to this option. No other changes were made in the various runs, other than to scale the individual index values for each index to enable a direct comparison with the OCI analysis and decision strategies. Figure 11 shows that the score drops by about 10 points for each of the non-OCI indices and that there is an average annual increase in the overall budgets of \$148,900 for the PCR3, \$320,000 for the PSC and \$322,900 for the CSI based on the year 10 deferred cost totals (the actual optimized complete budget was \$650,000 for the OCI index). This is caused by the inability of these indices to properly select the correct streets for repair. This causes these streets to be pushed back in the decision process till the repairs for them are more expensive or they never do appear in the repair list, however, they still accumulate a larger and larger backlog or deferred cost.

The plots in Figure 12 further illustrate the characteristics of the four indices being evaluated. They also show the relative performance of each. Because of the inclusion of raveling the PCR3 shows better performance than that the PSC and CSI when looking at deferred costs, however, the score plots show it to be the worst at the end of the 10 year period with a continuing down word trend. The score trends tend to lag behind the trends in the deferred cost by 2-to-3 years.

It should be noted that most likely some of the projects, which are not being picked because of a given index would be in real life and the actual ten year performance would most likely vary from what is predicted here. However, the fact that it exists at all substantiates the increased benefit of using the OCI index for network level planning. This would obviously mean that it is also better at ranking projects at the single or current year level as well.

Figure 13 further substantiates this argument. This analysis is included in the CenterLine PMS Technical Manual and was done on the City of Redmond's database in the early 1990's. It shows that whenever you vary from a strait worst first ranking/sort based on the OCI your costs increase. This example actually shows a worst-case scenario when using the traditional cost effectiveness or cost benefit procedures.

CNI	CSI	OCI	PCR ₃	PSC	LMY	ac1	ac2	ac3	lca1	lca1	lca3	lc1	lc2	lc3	tc1	tc2	tc3	mp1	mp2	mp3	rv1	rv2	rv3	egr	egp	upt1	upt2	upt3	cuts
59	7	0	67	0	1989	1105	532		70			14			16							3							
55	35	0	67	0	1995	6829						44			2							3							
60	33	0	67	0	1995	2468									3							3							
46	7	0	63	0		1917			63			180			18							3							
47	10	0	96	0	1997	126	8		61			199			21														
60	8	0	67	0	1995	3433			24									192				3							
98	6	0	96	0	1999	752	1		520			20			8			232	1120										
53	39	0	63	58	1981				192			112										3							
60	10	0	63	0	1981	152			370			12			2							3							
60	34	0	63	12	1981	8			500						1							3							
29	9	0	17	9		4750	100	26				89						548	40	480			2		240				
100	7	0	93	0		4740			250									432											
17	25	0	17	22		4000		2				85						1424	62				2		35				0.3
100	7	0	93	0		3960			365						2														
10	23	0	26	50		2054	20	18							15			210	50	12			3		20		50		
56	7	0	59	17		260	240	260											278	1100		3				120			
15	32	1	52	67	1999	200	1250	50	34			120	489		62	8		10	92	30		3		80	520	5613	120	20	
21	10	1	43	40		1096	2372		155	36.5		137		43.8	20	58			1169			2			20		36.5		0.5
98	9	2	85	0	1985	12			1806			30			96			338											
98	9	2	85	0	1985	12			1806			30			96			338											
52	23	3	52	62	1999	270	450	70	175			75			50			44		125		3		15	2	24			
93	10	4	100	0	1999	200			200			75																	
93	10	4	100	0	1999	200			200			75																	
44	9	4	59	48	1999	740	520	244	189	20		191	15	15	118	100		750		36		2				1524			
100	9	4	96	0	1997	760	108								5			250											
95	10	5	96	0	1999	128			85			54			9			434											
50	39	5	43	46	1997		1250			200					19			150				2				475			
99	10	5	96	0	1983	388			30			14			6			36											
91	11	6	96	0		120			185			123			3														
48	22	6	63	0	1989	200			25			102										3							
14	93	7	85	93		126	12	24							6			246			2								3

Figure D14 Sample database listing sort by OCI.

Final Discussion

All of the above indices are currently in use within the state and are referenced within this manual. For this reason the user of these data should have an awareness of how these indices differ. If the discrete steps used in the PCR_1 calculations are compensated for, the PCR_1 and WSEXT/CSI values agree with each other within acceptable limits, the same is true for the PCR_2 and the CDI. However, the PSC and PCR_3 scores are in a world of their own, especially for alligator cracking in the case of the PSC, while the PCR_3 is all over the place. This is not necessarily of concern if an agency is using one index or the other, unless they are to change from one year's survey to the next. However, it could affect your MR&R decisions or the process used in making these decisions and obviously when comparing different indices between agencies.

Also, there is another area of concern which local agencies should be aware of. When considering how your agency's data will compare with other agencies within the state, extreme care should be taken of how you rate alligator cracking and patching and what index calculation procedure is being used. Alligator cracking dominates the PSC index and will be the key distress when comparing data between agencies; however, the potential for variation in how various agencies rate patching and how each performs their relative maintenance has even a greater potential effect. For example if an agency does a lot of relatively long skin or blade type patches or pre-leveling (can be considered an overlay at some point) and they classify these as patching and not a rehabilitation they benefit substantially when compared to an agency which does not do this type maintenance or which does not classify it in the same manner. This type of patch covers the full pavement area in question and would thus be assigned an extent of 100%, if considered a maintenance patch. This would result in a much higher deduct than if the underlying distresses were rated separately or the patch is considered an overlay.

Another more common example would be in how an agency quantifies or defines a given distress. If this varies from one agency to another, and the same index is calculated, it will not produce the same results.

Summary and Recommendations for PSC Calculations

This index is based on a concept of equivalent alligator cracking, which attempts to convert Longitudinal Cracking, Transverse Cracking and Patching to an equivalent amount of Alligator Cracking. There is no sound physical meaning to this concept other than that WSDOT actually defines Longitudinal Cracking and Patching as different severities of Alligator Cracking. However, if it is to be used for state-wide comparisons it becomes extremely important that your agency use the same MR&R practices and rating procedures as WSDOT if you are to try to compare your data to theirs and other agencies. Unfortunately this is incompatible with the true concepts and benefits of a pavement management system and could force agencies into adopting MR&R practices, which are not optimal for their individual roadway networks and funding situations. Therefore, local agencies should not use this index.

Summary and Recommendations for PCR3/StreetWise Calculations

The primary reason given for the development of this index was to develop a paper and pencil procedure for rating the pavement and selecting MR&R actions for small agencies. Ironically, the PAVER/ASTM method was originally developed as a paper and pencil system and thus the WSEXT or CDI method can be done manually as well. (See the US Corp of Engineers, Technical Report M-294, Oct 1981). Also, the PCR_1 and PCR_2 can be used as a paper and pencil based method in a much easier manner than StreetWise, one page of deduct matrices and one step/line

of calculations versus four pages of matrices and several calculation steps. However, there is one advantage when comparing the PCR₃ to the PRC₁ or PCR₂ methods. More detailed data is collected (even though it is not used) when using the StreetWise (PCR₃) method and this data could be used to compute the PCI, CDI or PSC indexes at a later date. Also, the values produced by the PCR₃ index are so far removed from any other index currently in use, that care should be taken in comparing it to other indices, see Figures 1 thru 4. Also, if you are going to collect detailed data; use it, why go back to using a matrix method when you could just as easily use continuous deduct curves as in the PAVER/ASTM procedures. Also distress types other than the five used in this method are of value to the decision process, especially for maintenance operations. Also, only two distresses are reflected in the final PCR₃ score and the second distress can vary from one segment to the next and one survey to the next. This presents some concerns when prioritizing streets based in the PCR₃ in that streets with a different second distress type cannot be differentiated and the other distresses are not included at all. Also, what happens if there is no alligator (fatigue) cracking, but other distresses are present, are these segments being prioritized properly? Raveling is the more predominate or controlling distress in low volume roads and in these cases, raveling most often occurs without alligator cracking.

StreetWise is also referred to as a Pavement Management System (PMS). The term PMS is an extremely general term but to refer to the StreetWise procedures, as a PMS is somewhat of an overstatement. At a minimum a PMS has a database, budget planning and scenario comparison capabilities and the ability to analyze the impact of your decisions. Look at the AASHTO definition of a PMS in "AASHTO Guidelines for Pavement Management Systems, July 1990". A better description might be a pavement management procedure, which follows or extends the natural process used by pavement rehabilitation and maintenance decision makers. That is, look at the street and decide what should be done to it and when it should be repaired based on existing funds. StreetWise is really just a rating system which suggests that the user sort or prioritize its results on this rating and assign a MR&R action based on five score ranges or groups defined by these scores. This is not a PMS by the AASHTO definition.

However, a full-blown PMS is not needed or does not necessarily even work for extremely small agencies and therefore, this procedure is adequate for its intended application if the PCR₃ index contains the distress data needed to manage your roadways. Also, this procedure could be simplified further by adding the matrices and some equations to a simple MS Excel spreadsheet or a little code to an MS Access form or database. It's hard to believe that even the smallest agency doesn't have a PC. Also, if this is done, it's just as easy to add the deduct curves as it is the matrices to the same spreadsheet. This would be less than a days work for someone skilled in the programming of a spreadsheet.

Appendix E

CenterLine Pavement Distress Definitions

